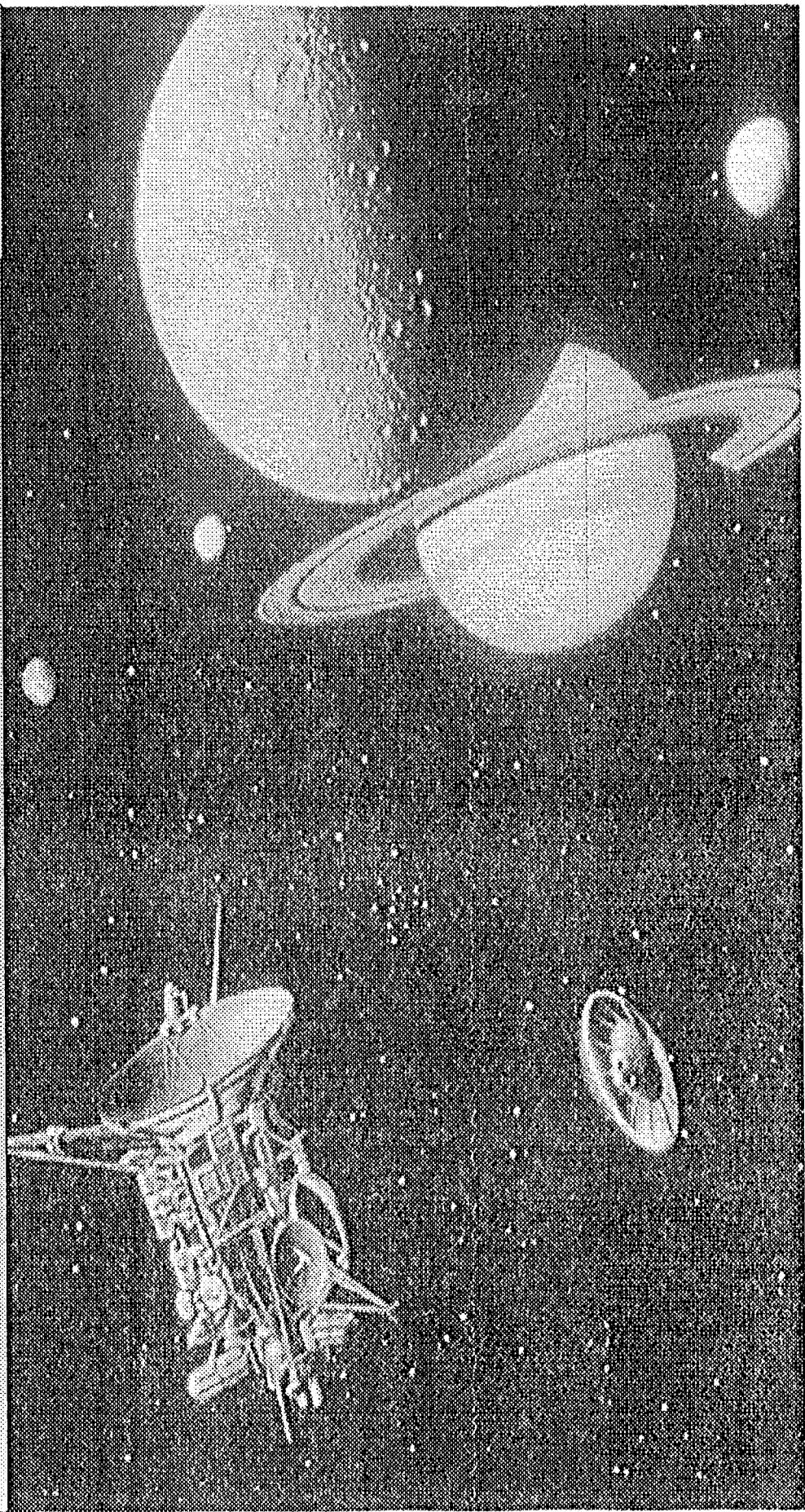




JPL Hemispherical Resonator Gyro An IRU for Cassini



Lynn Gresham, Jet Propulsion Laboratory
February 19, 1997

Introduction

- The Hemispherical Resonator Gyro (HRG)
- IRU Requirements
- Cassini Configuration Change
- Shopping for an IRU
- Cassini IRU Configuration
- Litton's Standard SIRU and Adaptations for Cassini
- Performance of the Cassini IRU
- Conclusions

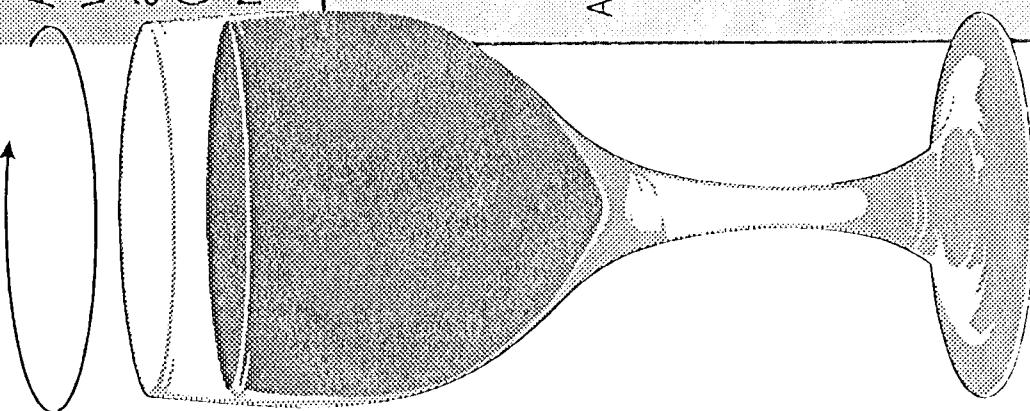
The Hemispherical Resonator Gyro (HRG)

Description of the HRG

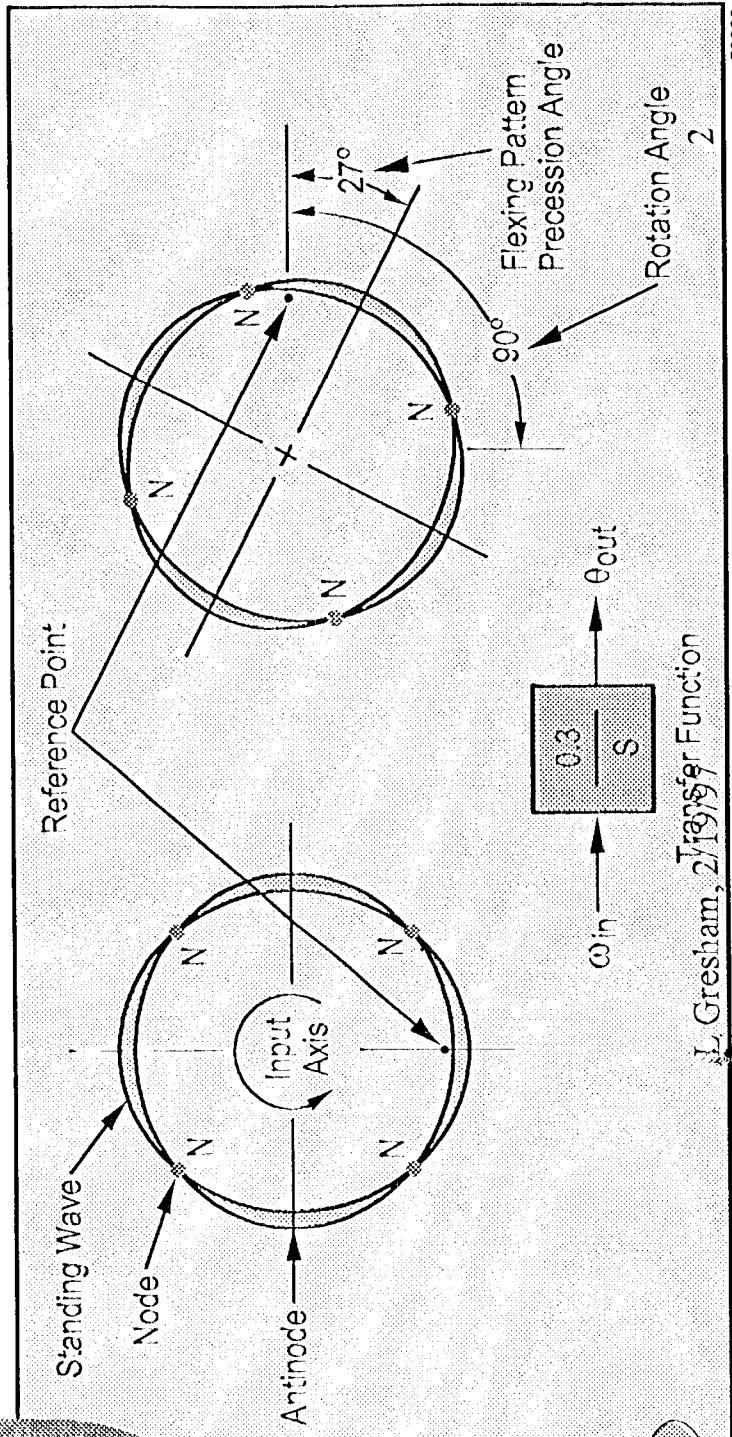
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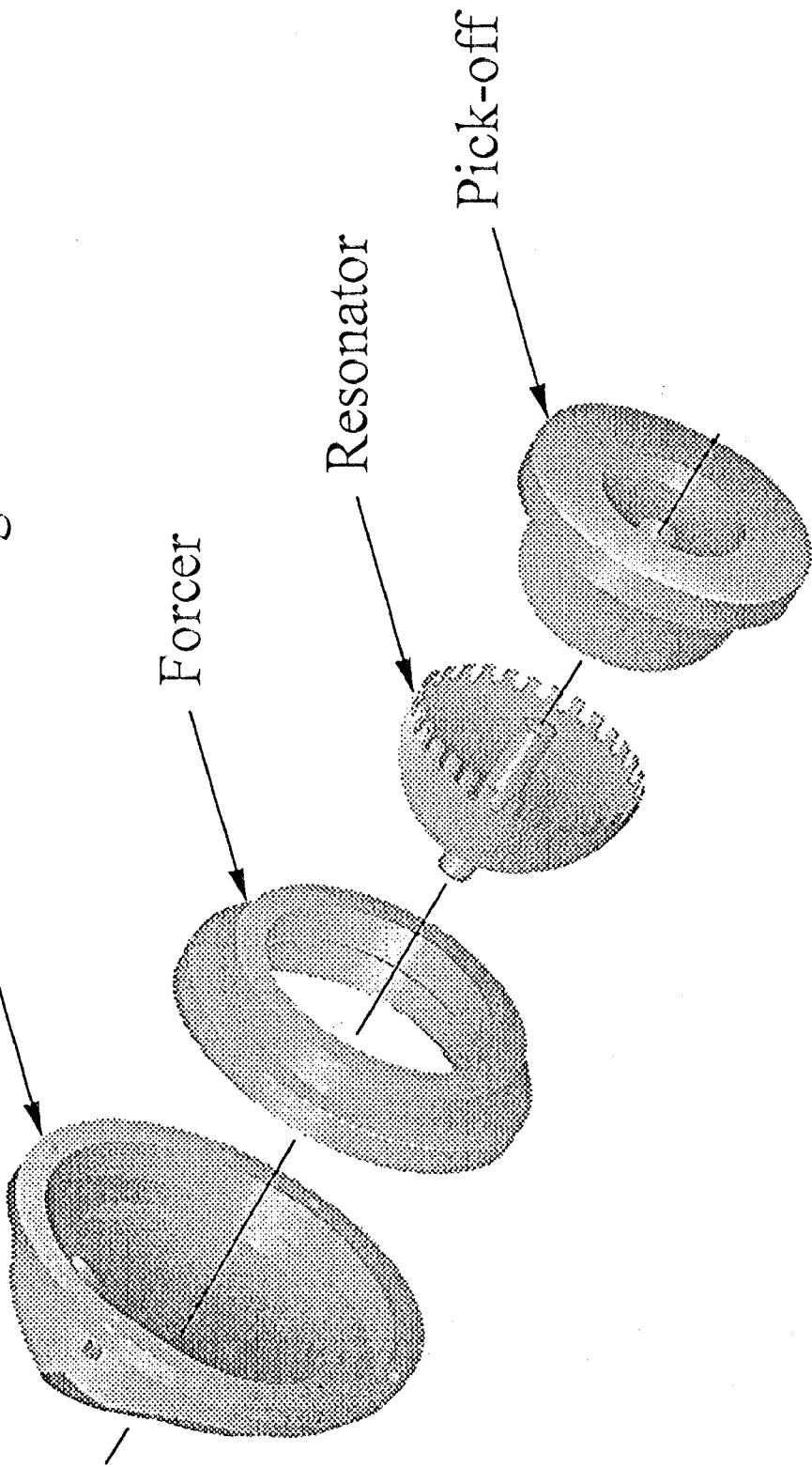


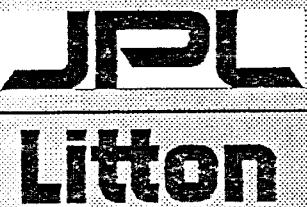
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Littton

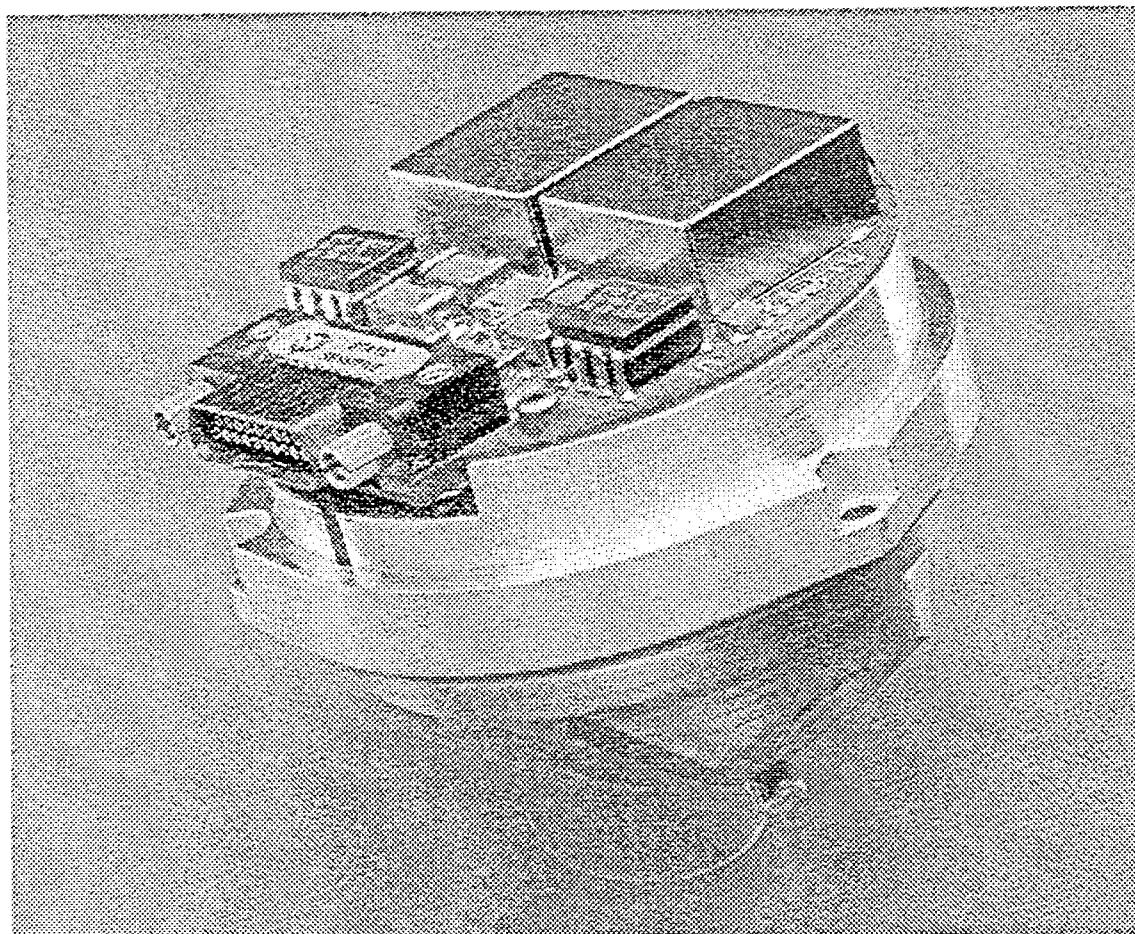
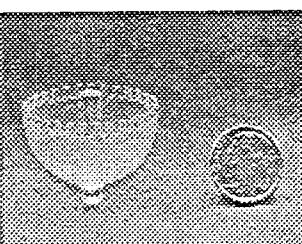
Basic components of the Hemispherical Resonator Gyro: Invar Cap, Forcer Ring, Resonator, and Capacitive Pick-off

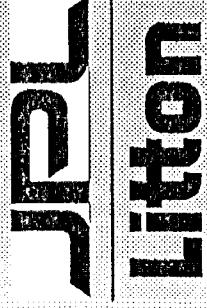
Vacuum Housing and Getter





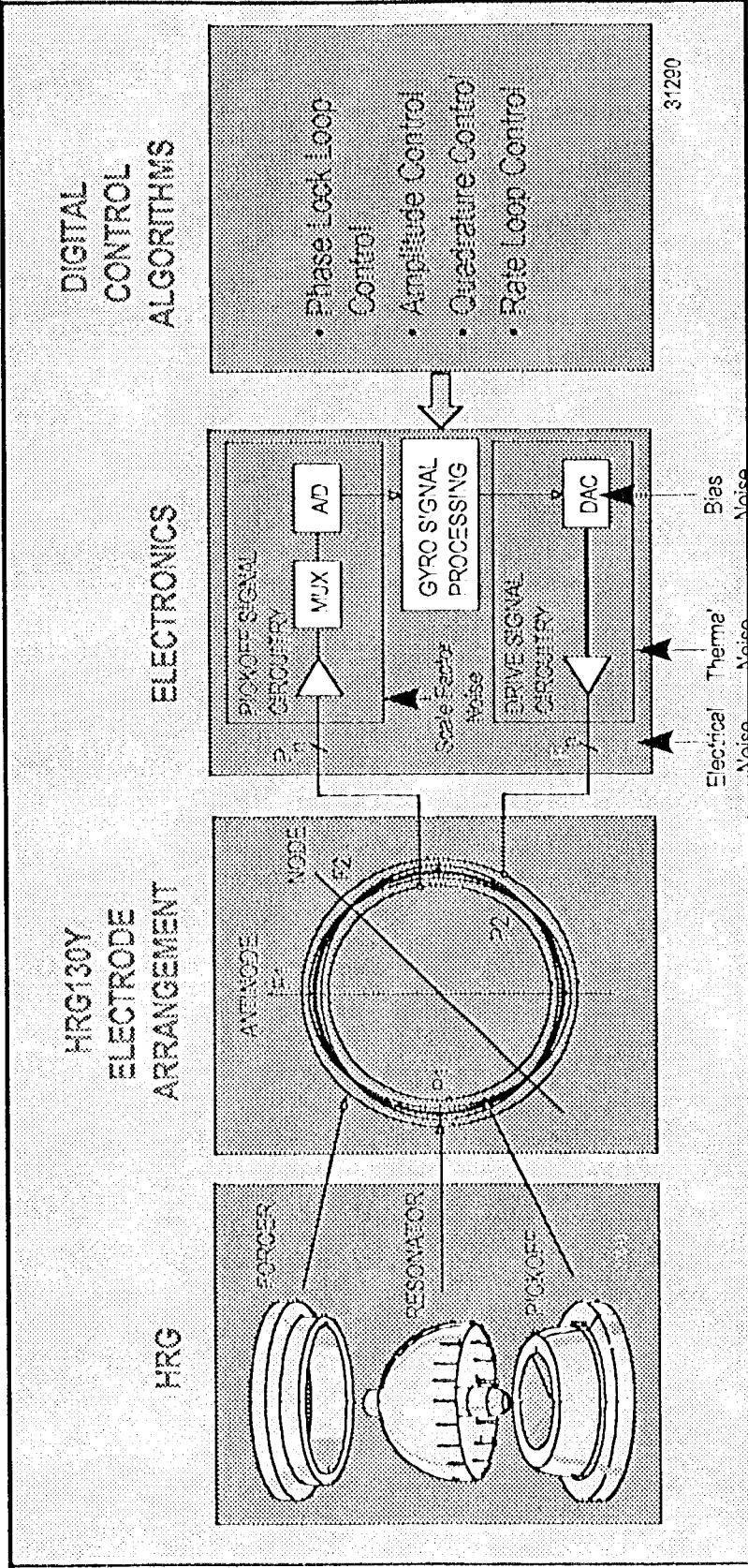
Encapsulated HRG showing the Buffer Electronics Card





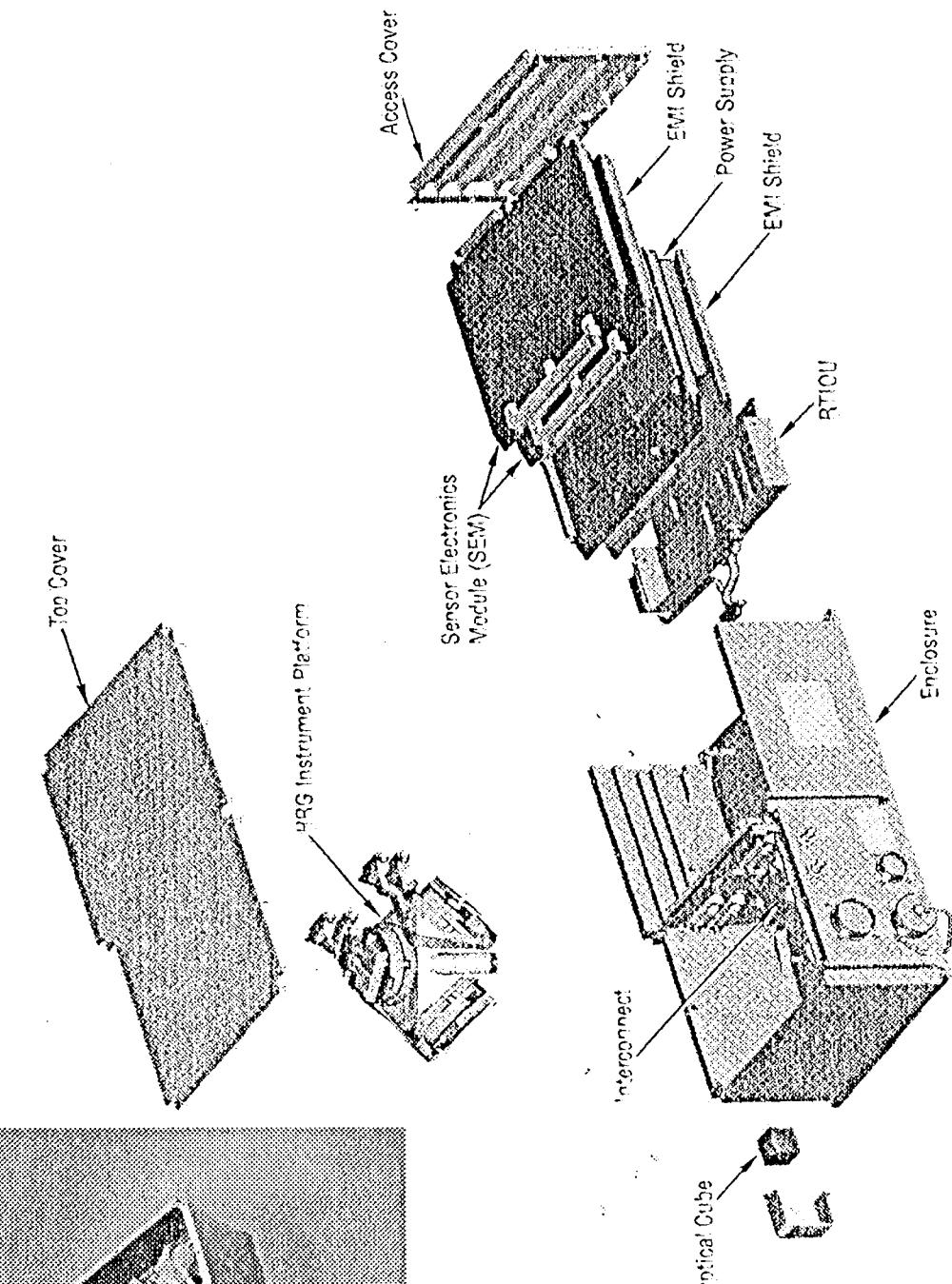
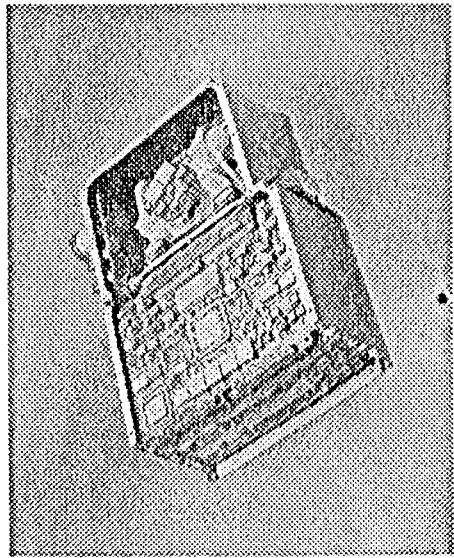
The IRU mechanization

Littton uses three basic components and associated control electronics in its HRG mechanization.





Exploded view of the Cassini IRI

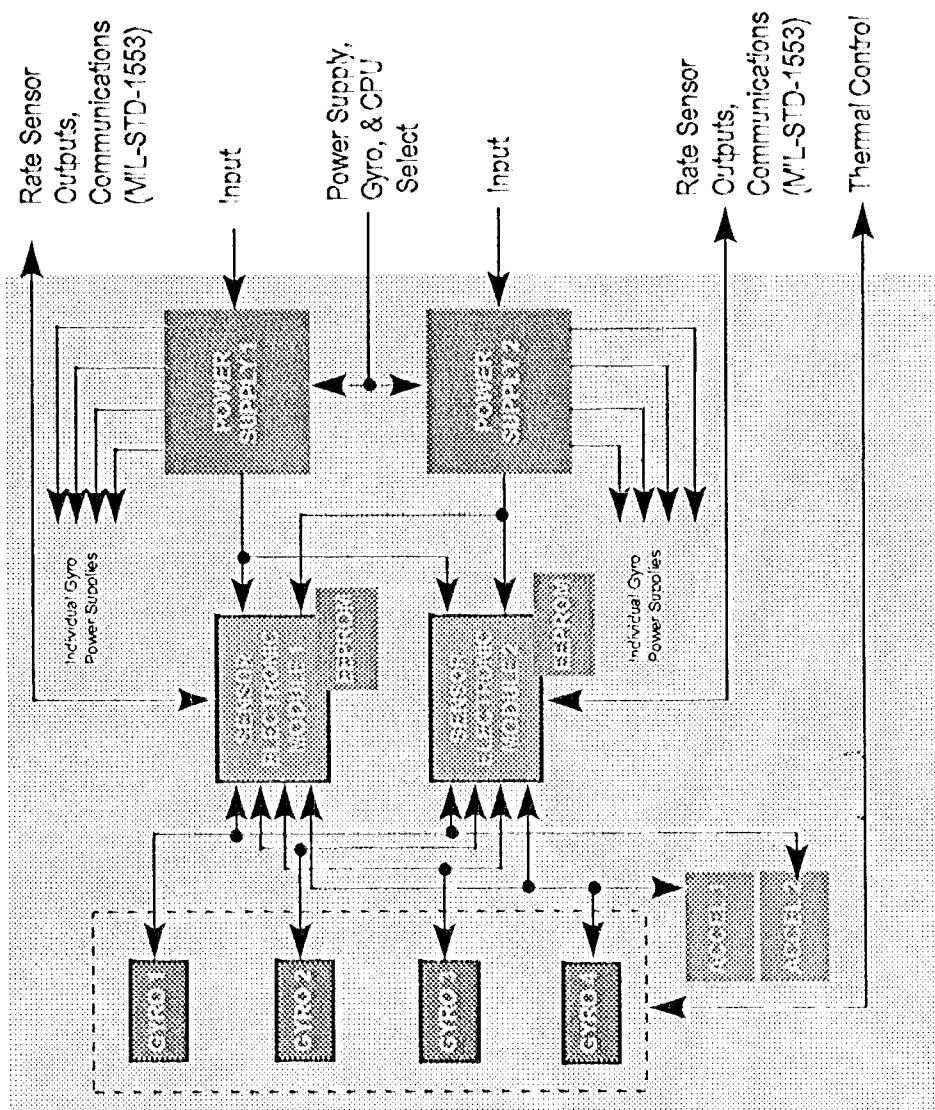


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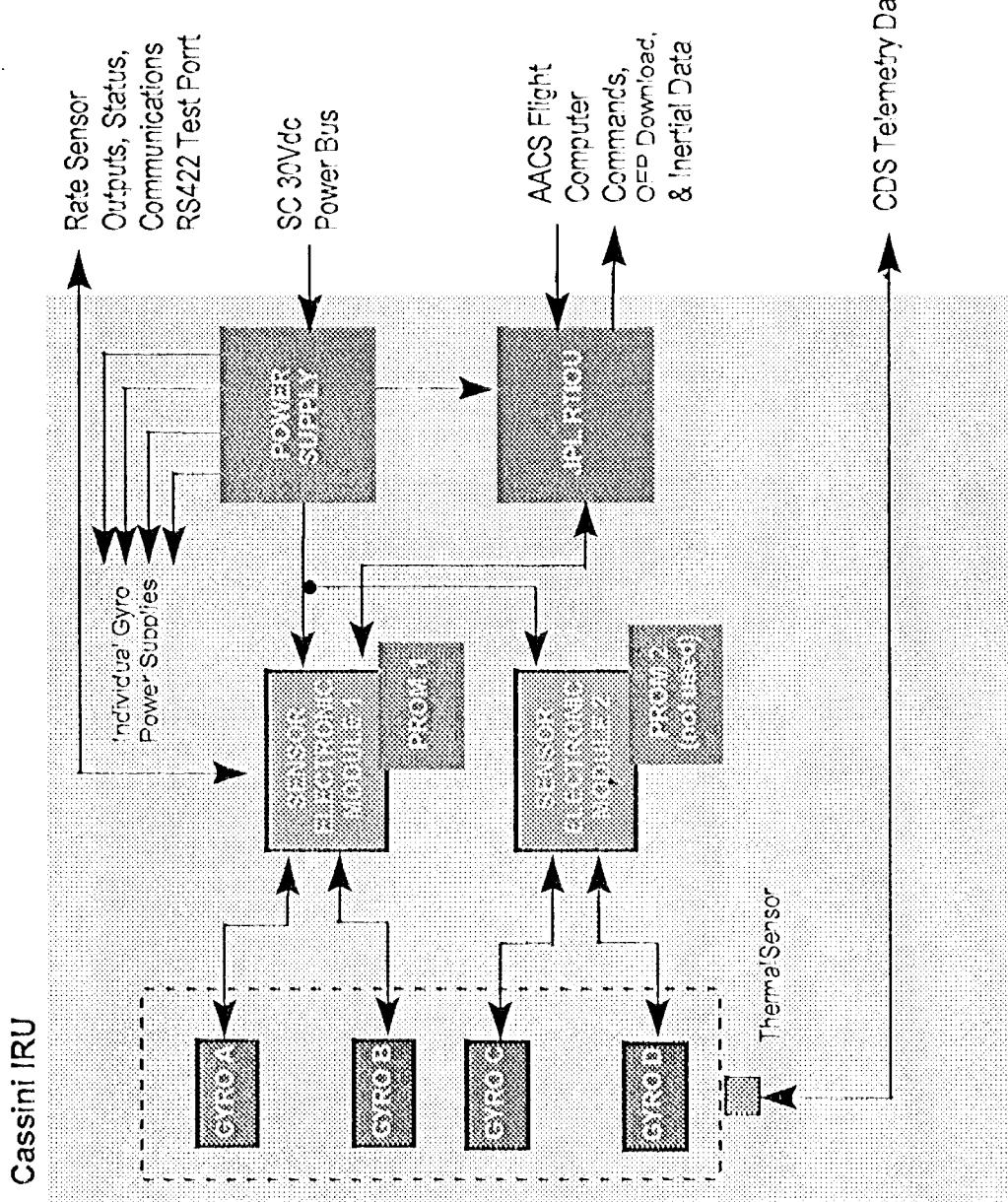
SIRU Functional Block Diagram

CORE SIRU





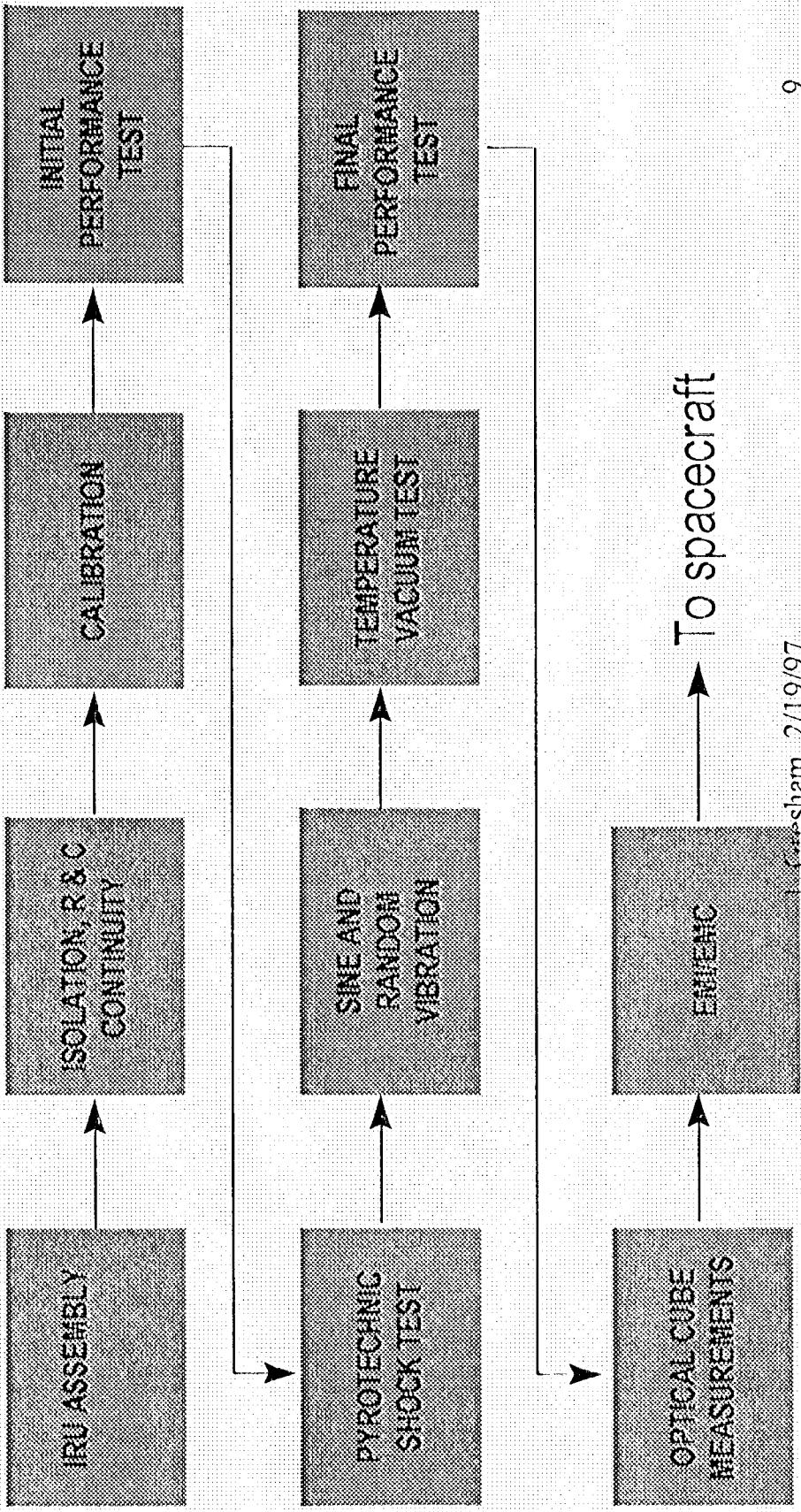
IRU Functional Block Diagram





Cassini IRU Test Flow

Cassini IRU Protoflight Test Sequence



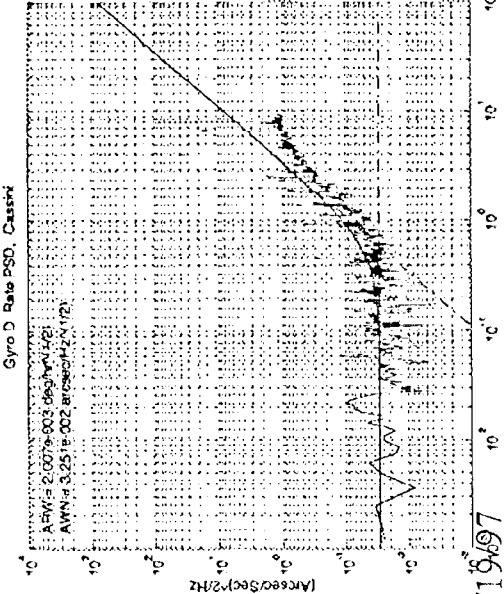
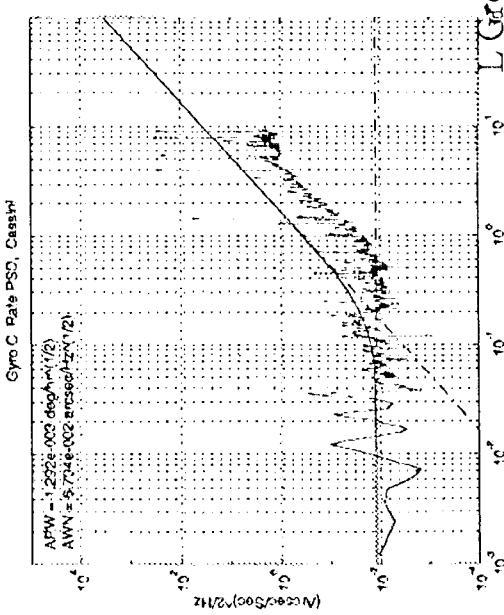
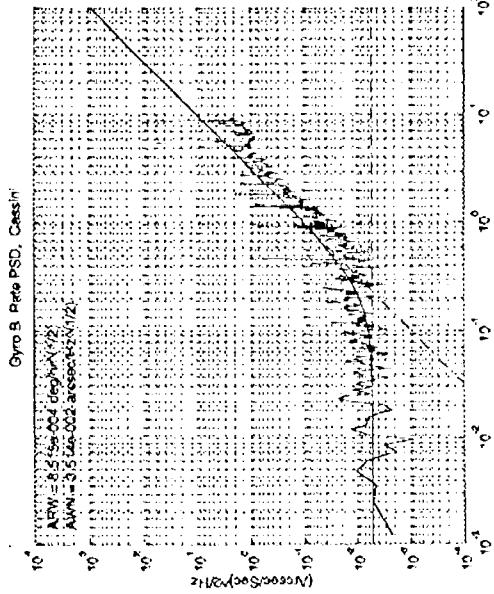
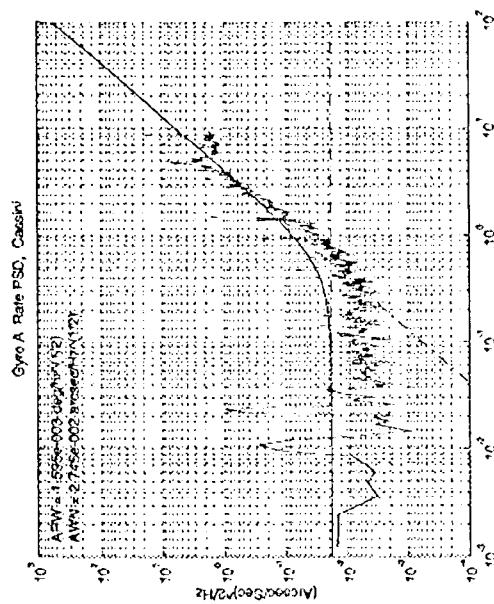


Cassini IRU Performance Results based on Flight Acceptance Test Data

Parameter	Cassini Requirement	Flight Acceptance Test Results	Gyro A	Gyro B	Gyro C	Gyro D
Noise						
Angle Random Walk ($\text{^{\circ}}/\text{hr hr}$)	0.0025	0.0016	0.0008	0.0013	0.0020	0.0020
Angle White Noise (arc-sec/ $\sqrt{\text{Hz}}$)	no requirement	0.0275	0.0351	0.0670	0.0325	0.0325
Scale Factor Stability (ppm @ $3-\sigma$)	500 ppm	150	209	90	129	129
Bias Drift						
Constant Bias ($^{\circ}/\text{hr}$ for 8 hrs, $\pm 10^{\circ}\text{C}$)	0.3 required	0.148	0.039	0.048	0.143	0.143
Stability ($^{\circ}/\text{hr}$ @ $3-\sigma$)	0.03 goal	0.005	0.017	0.012	0.039	0.039



Typical Power Spectral Density for the Cassini IIRU

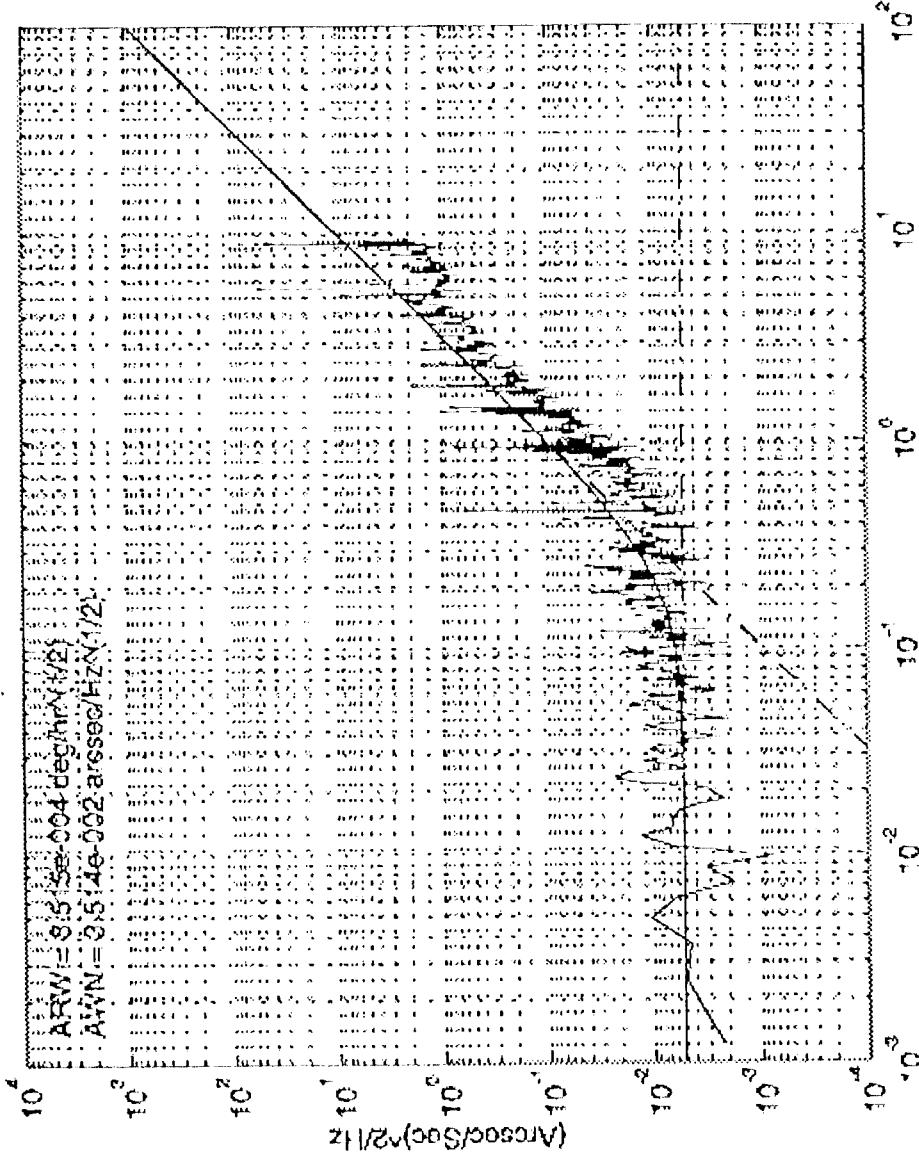


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Typical Power Spectral Density for the Cassini IIRU, Gyro B

Gyro 3 Rate PSD, Cassini

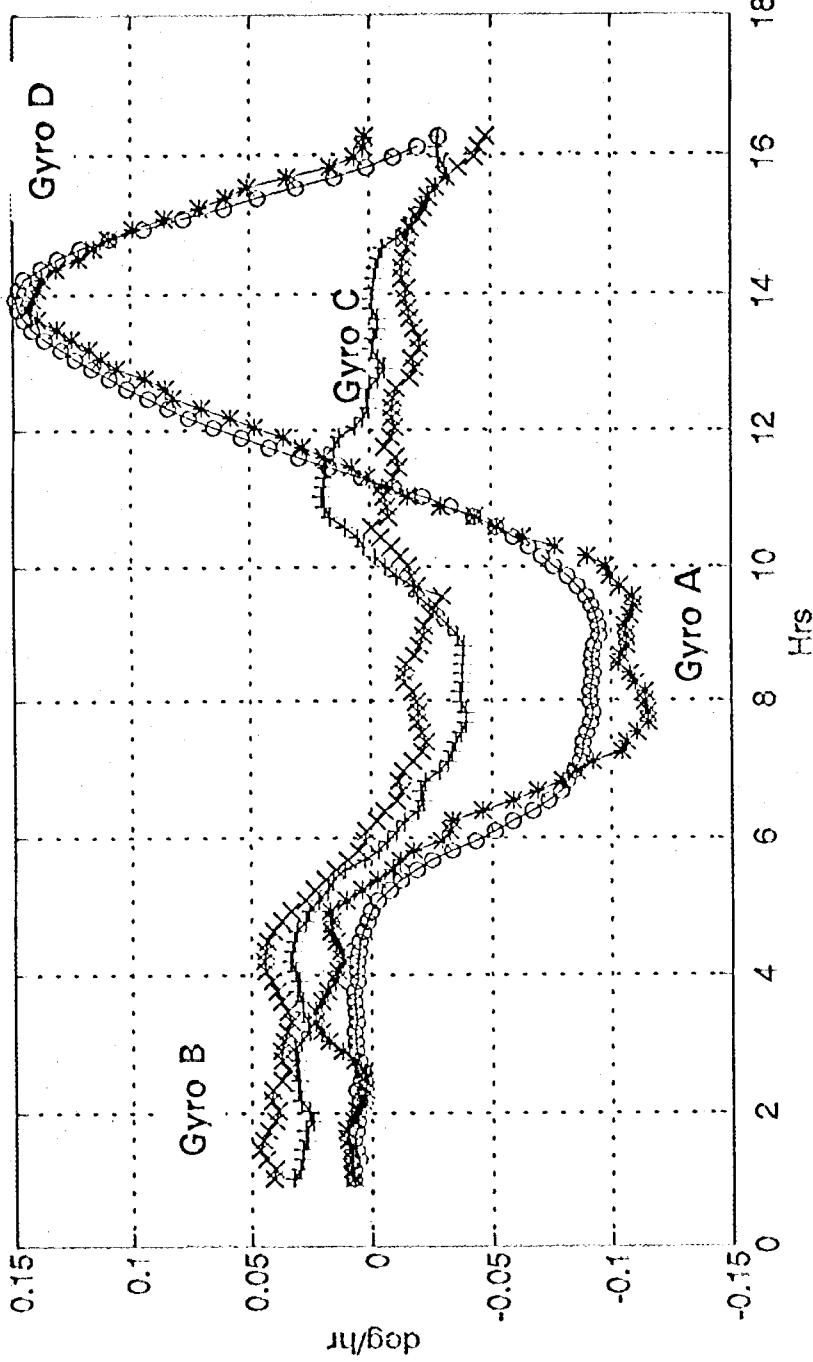


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Cassini IRU Bias Stability

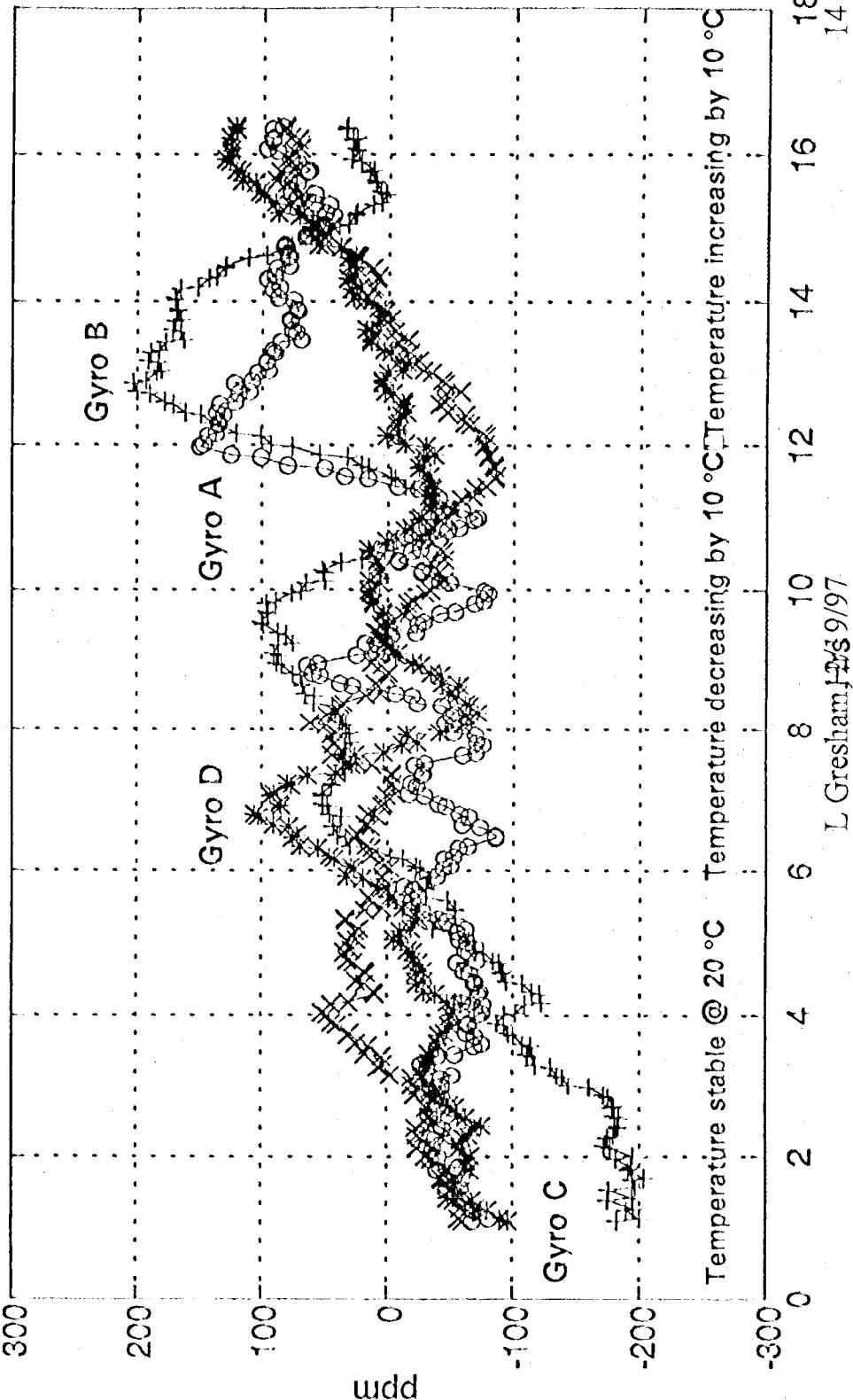
Bias Temp Transient [$\delta + x^*$] A=0.148 B=0.039 C=0.048 D=0.143 deg/hr





Cassini IRU Scale Factor Stability

Scale Factor Temp Transient [o+x*] A= 150 B= 209 C= 90 D= 129 ppm

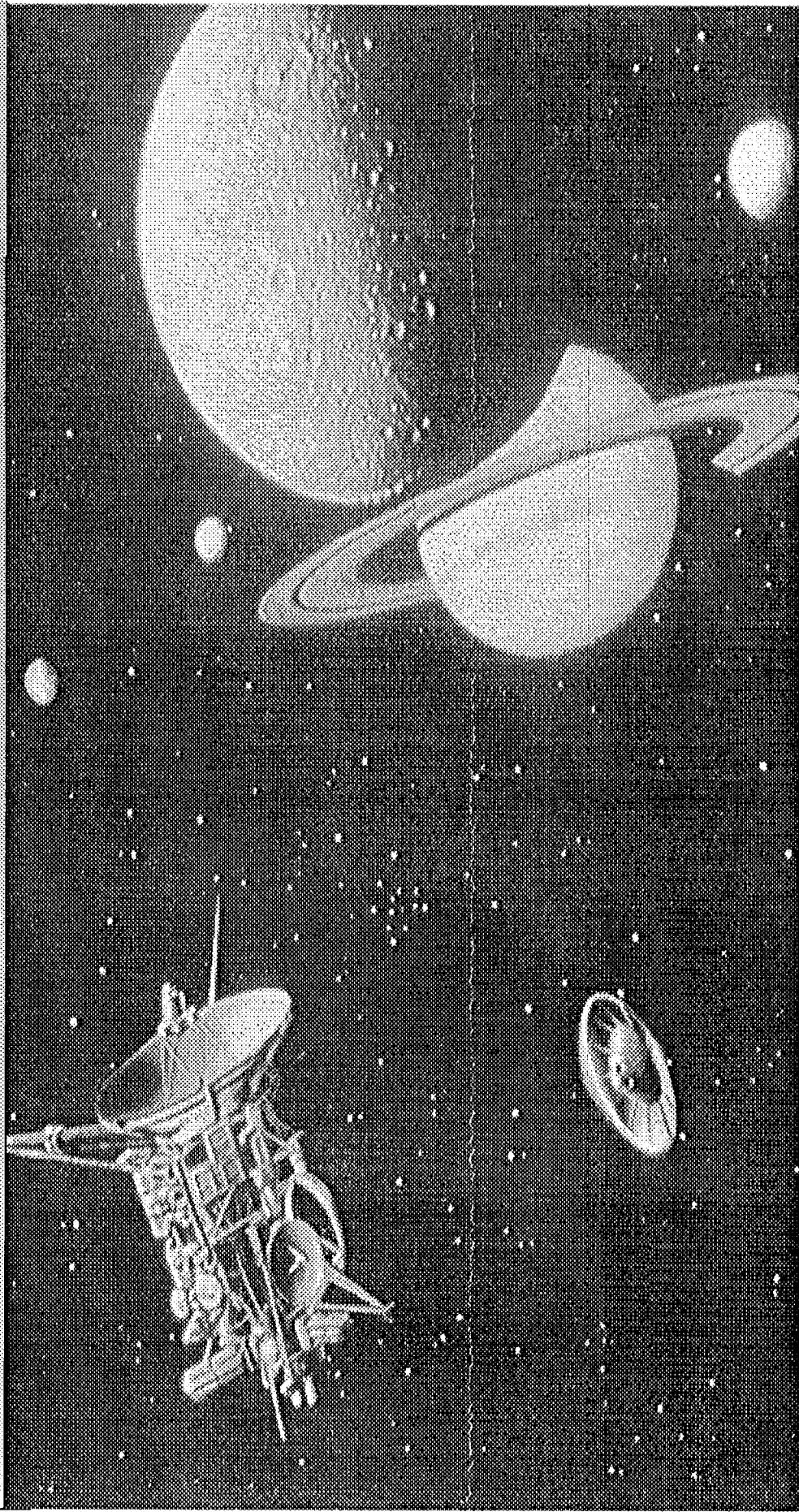


Conclusions

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- The Litton HRG is an ideal choice for spacecraft applications. It offers a combination of stable materials, simple construction, modern electronics, and no moving parts.
- The Cassini IRU will serve as a test of the effectiveness of this technology in the harsh environment of Saturn and its rings.
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Litton

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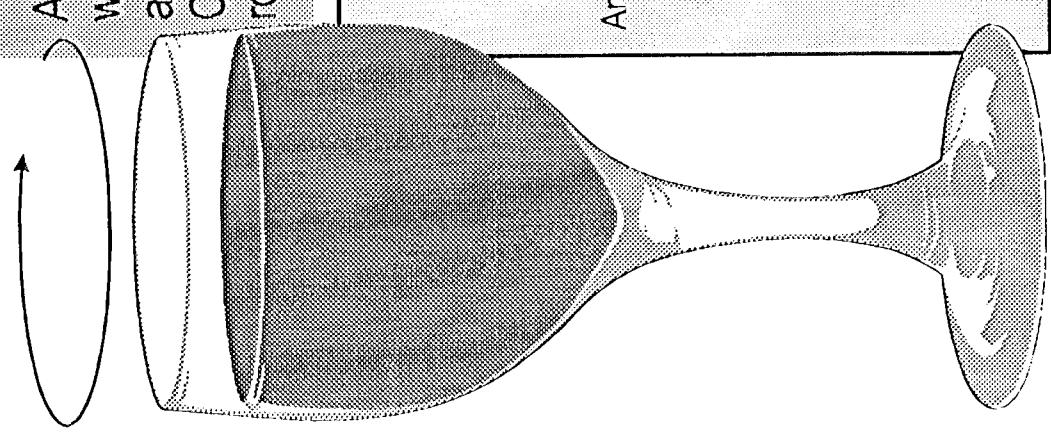
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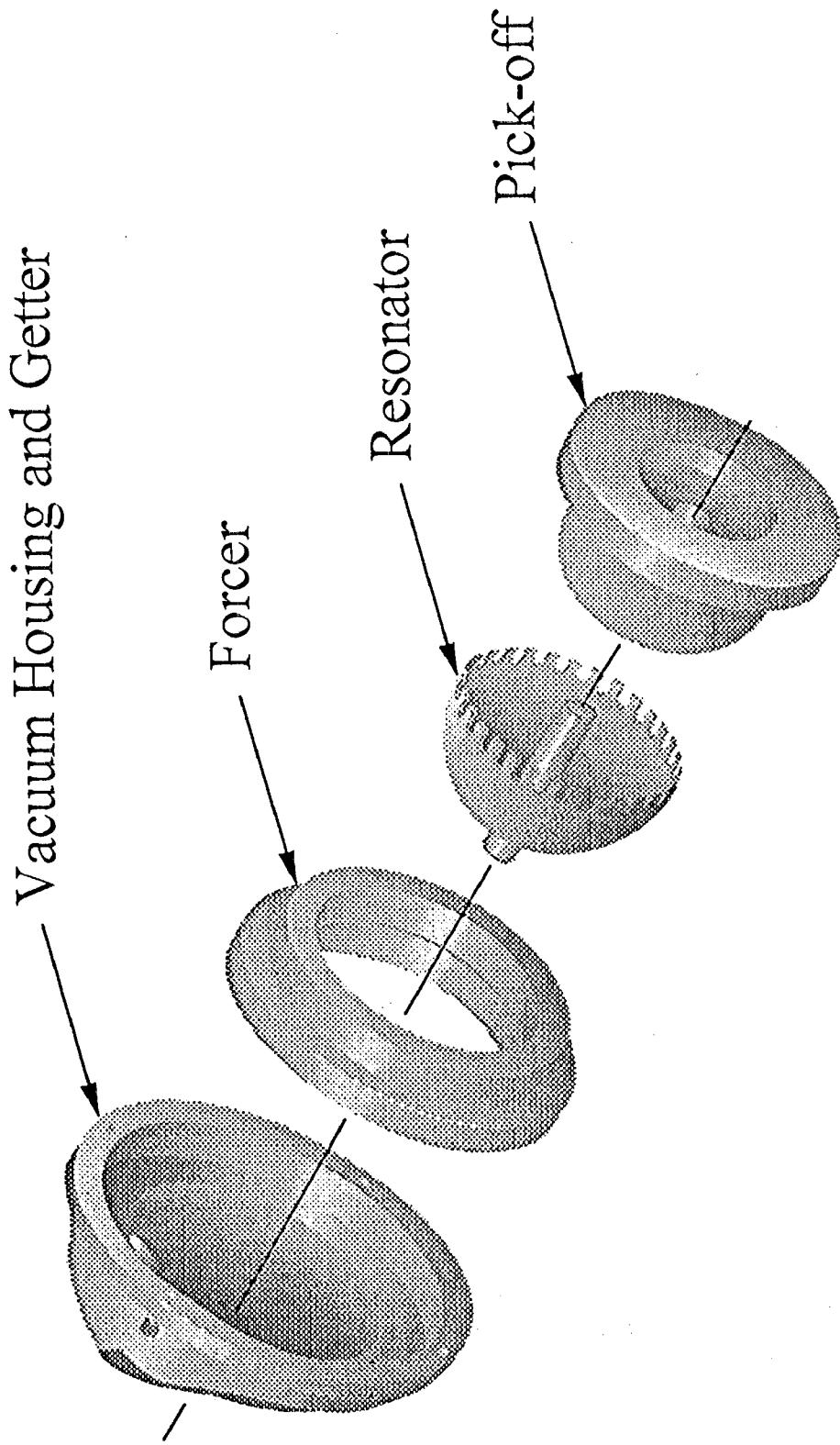
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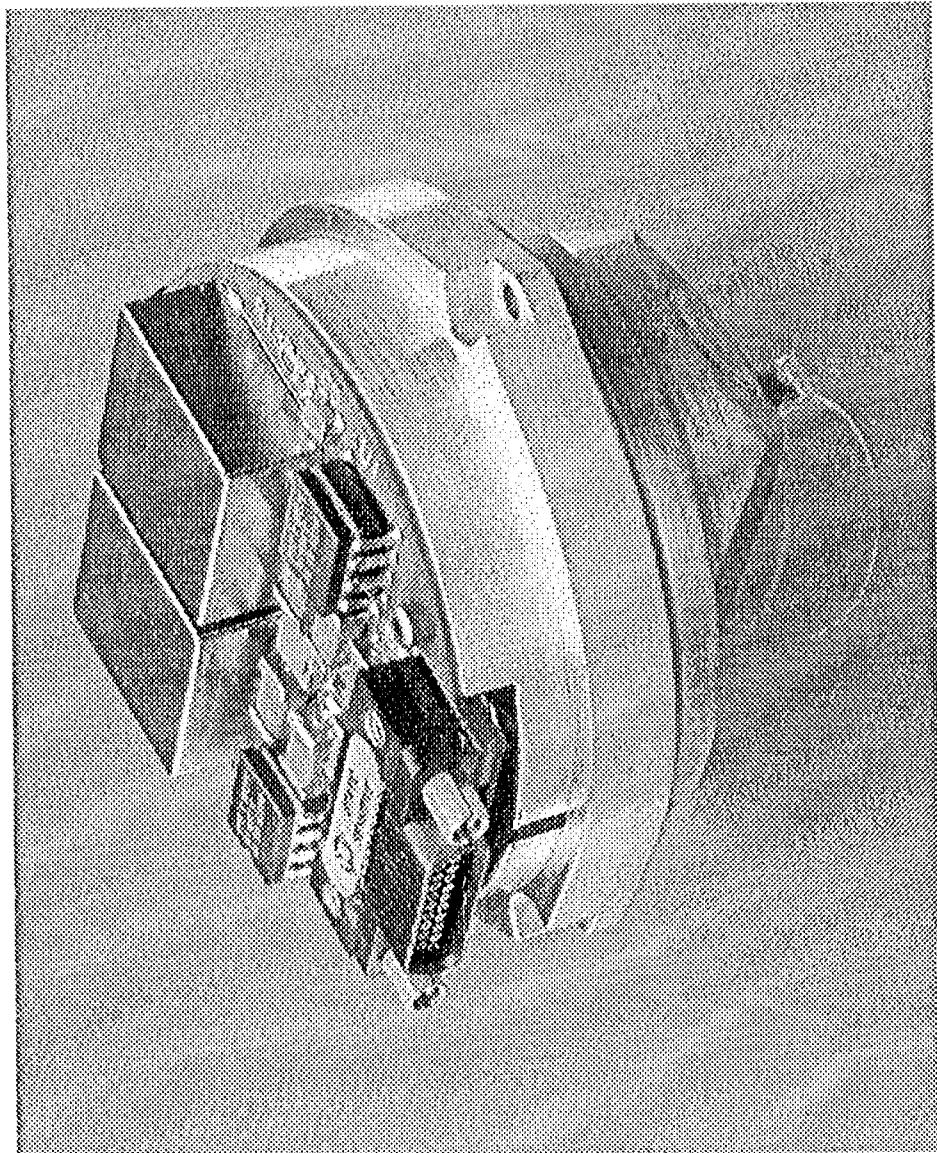
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Littton Basic components of the Hemispherical
Resonator Gyro: Invar Cap, Forcer
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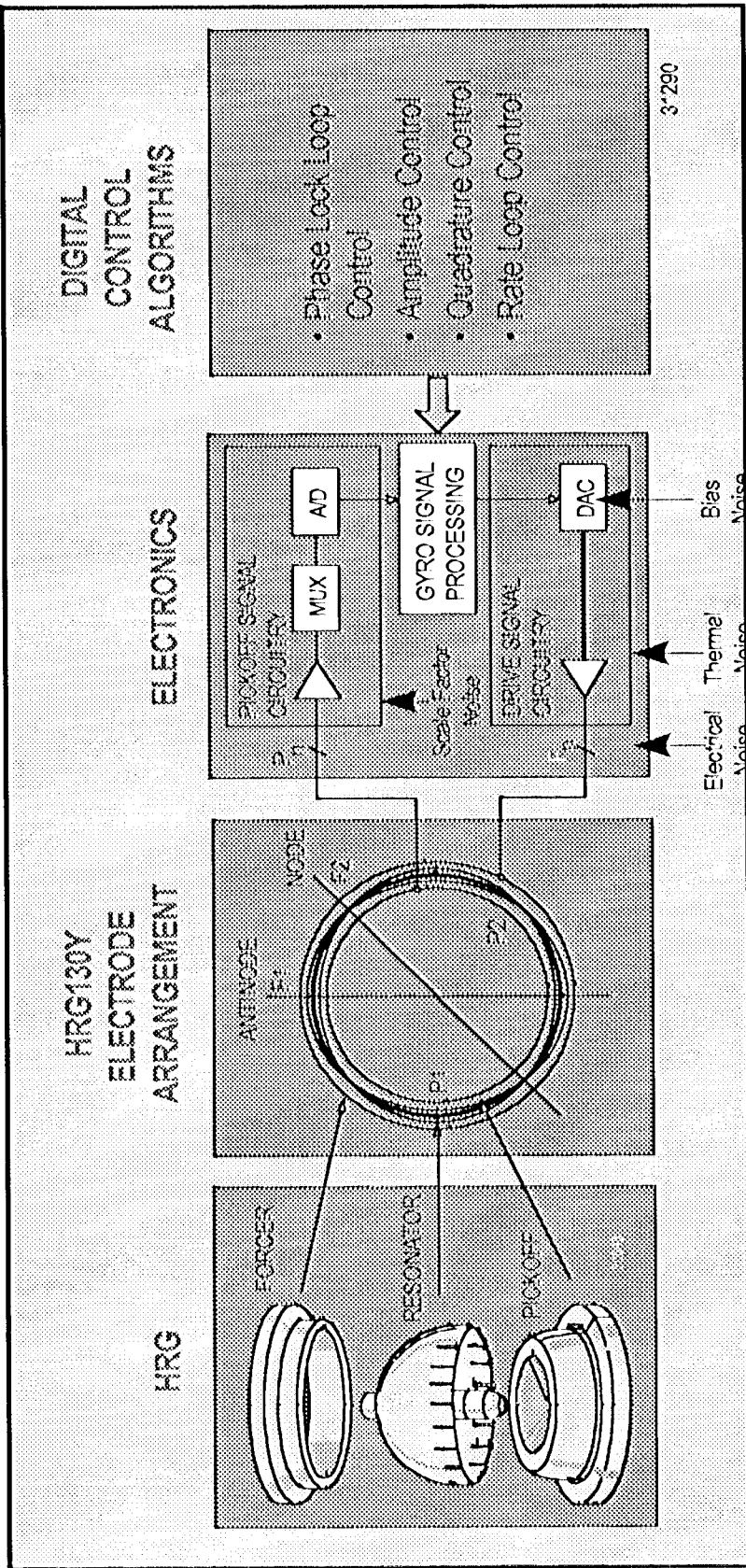
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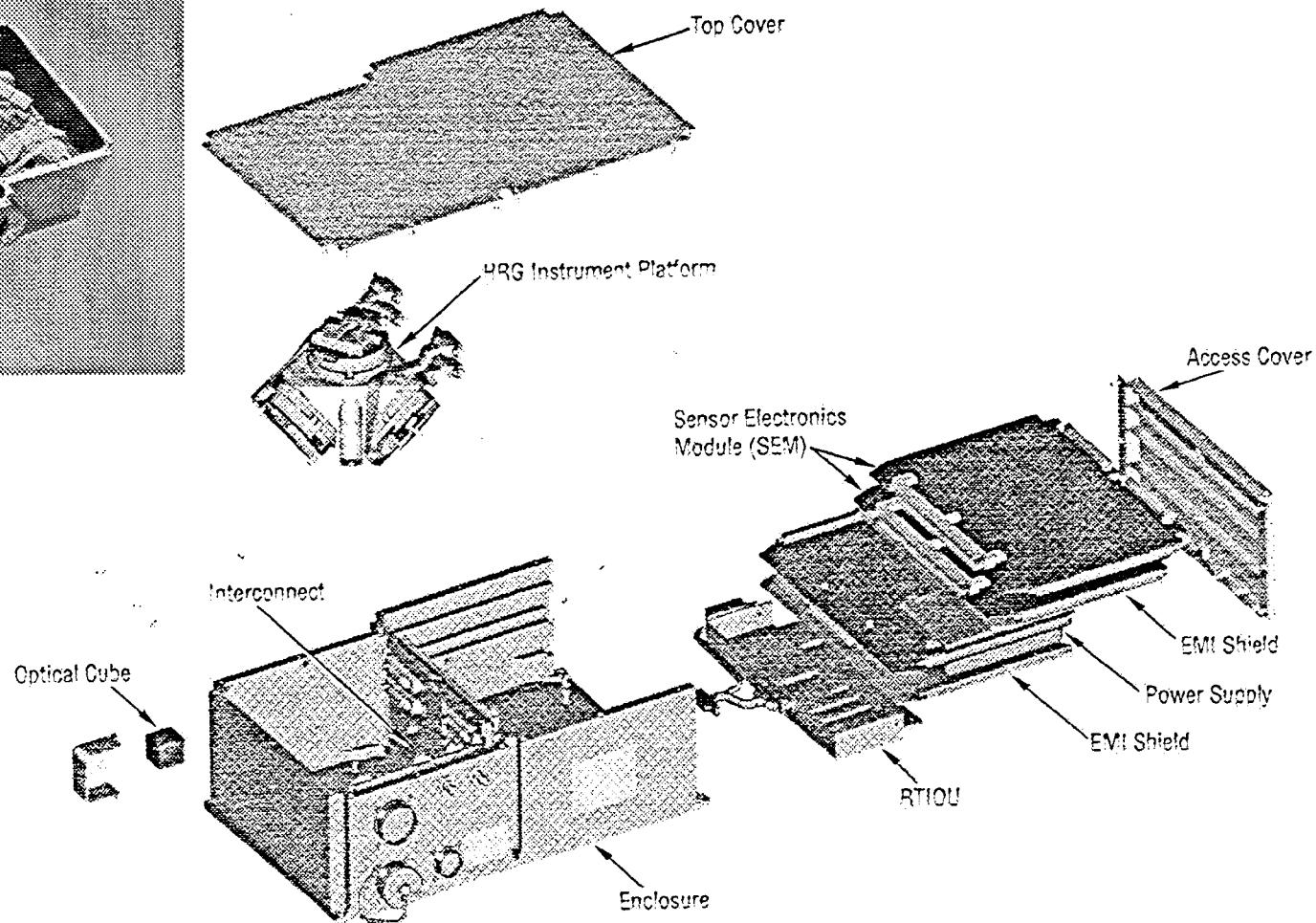
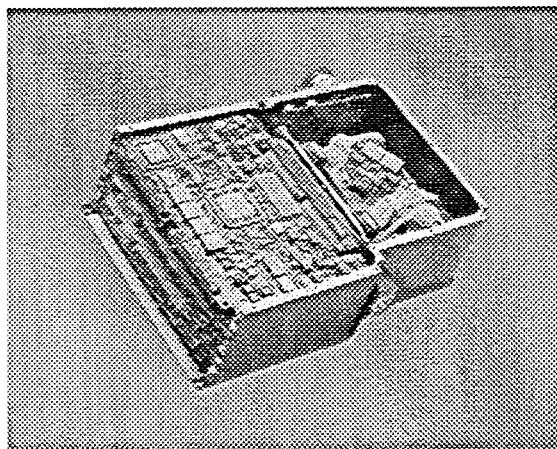


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Exploded view of the Cassini IRU

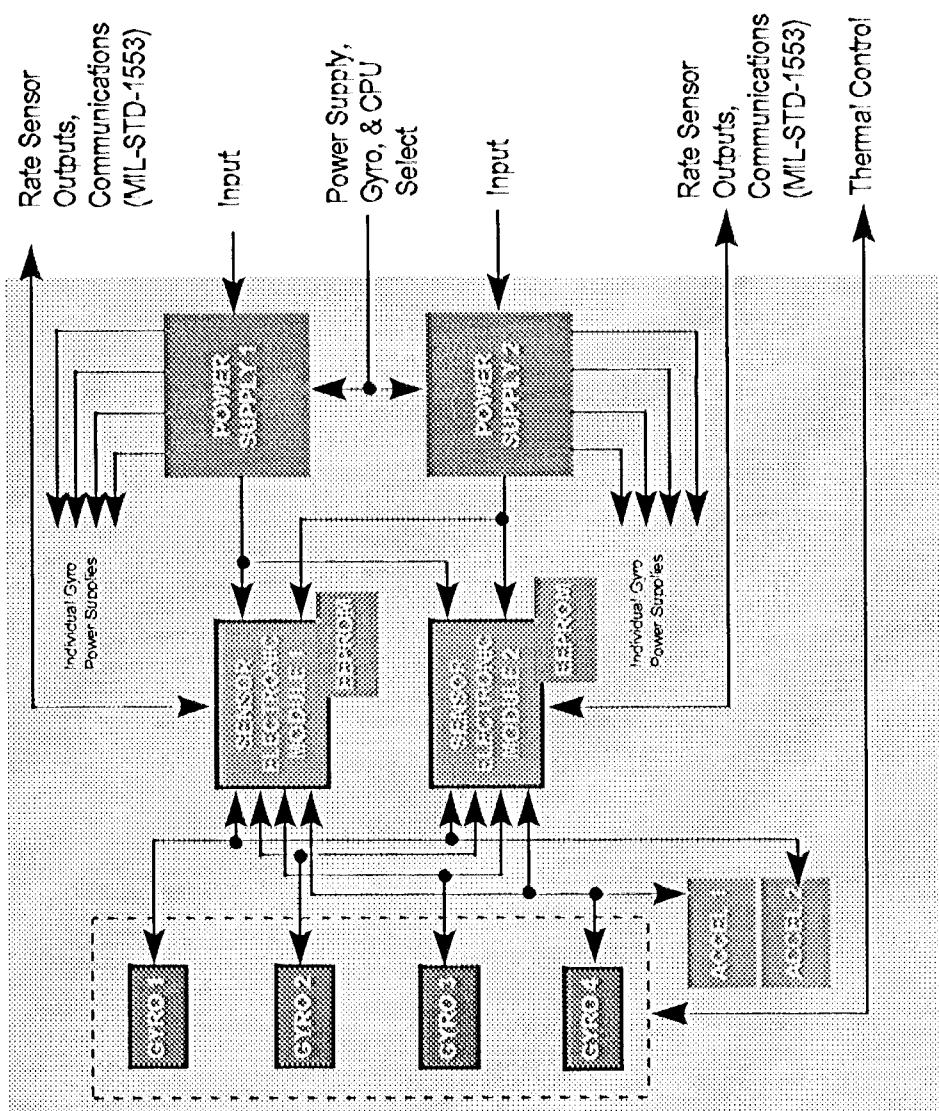


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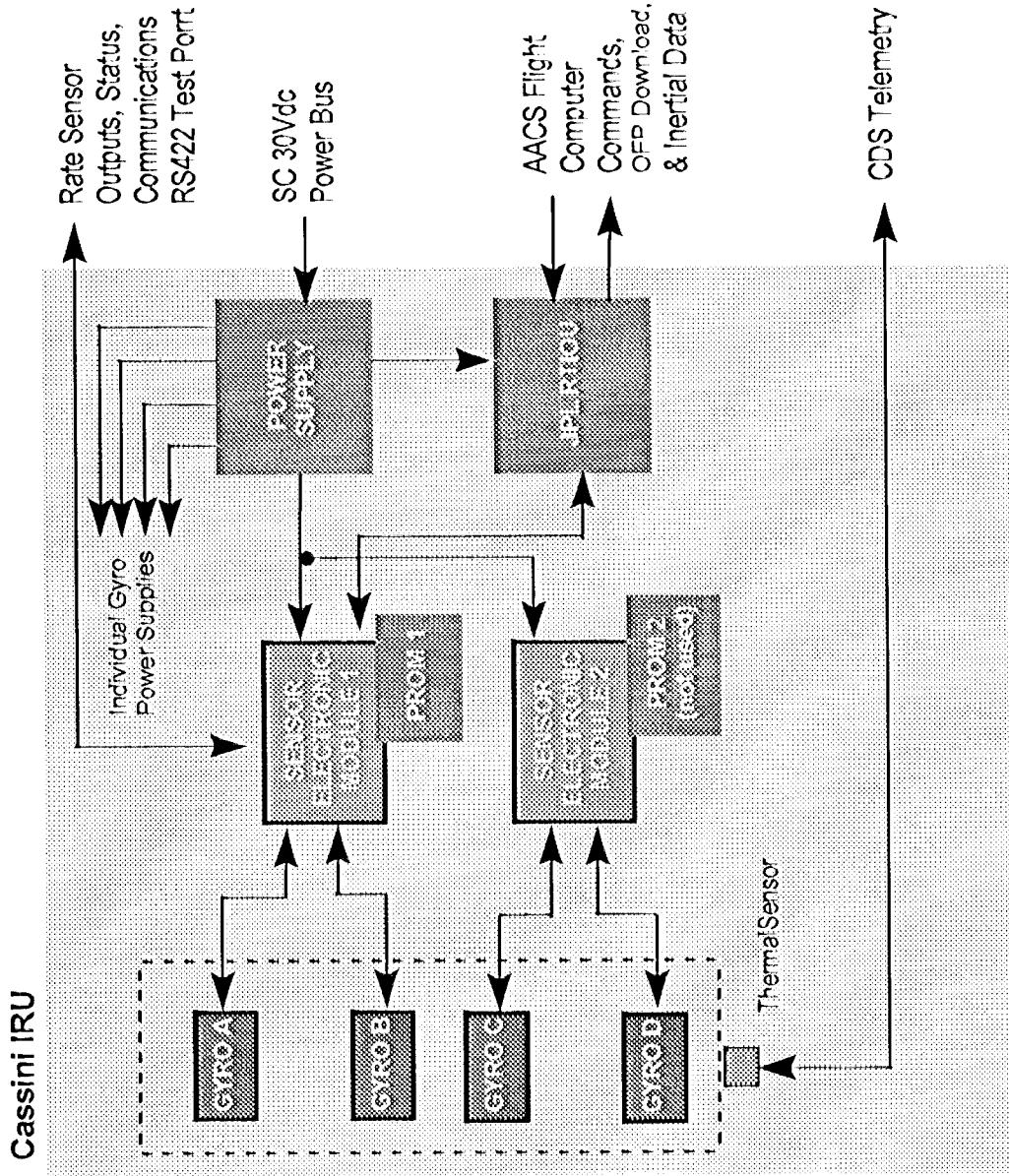
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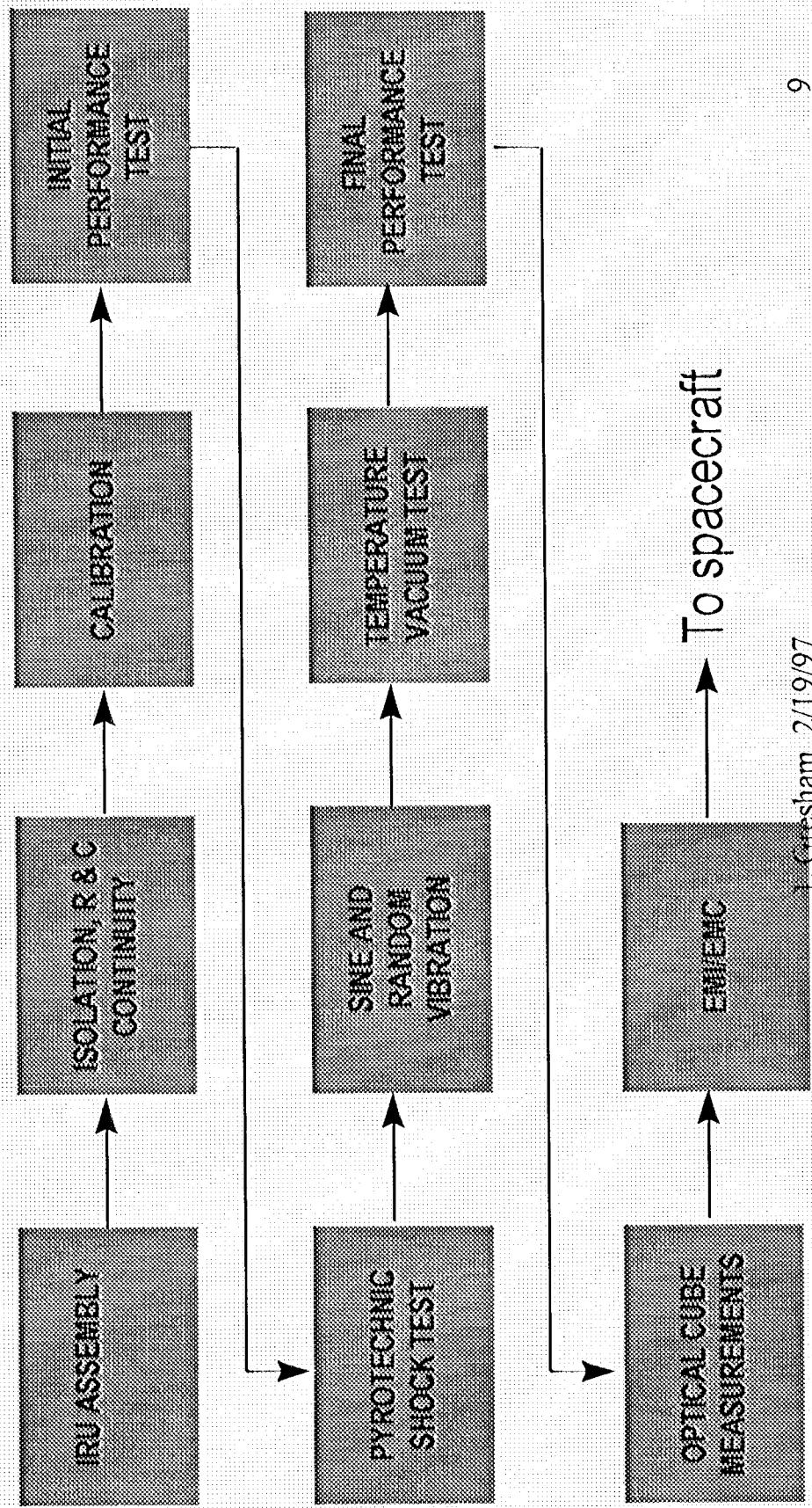
IRU Functional Block Diagram





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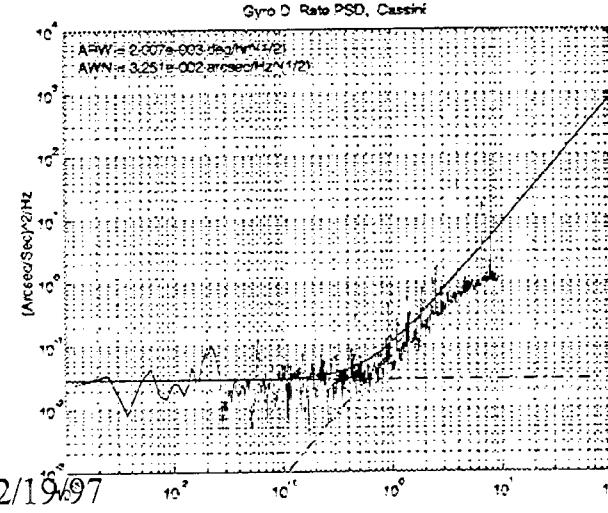
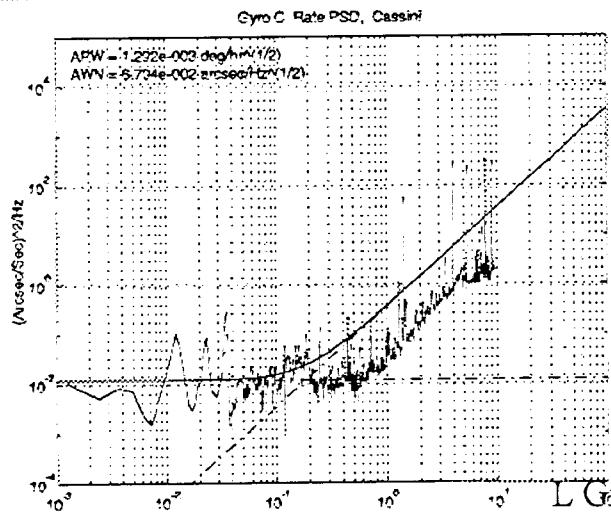
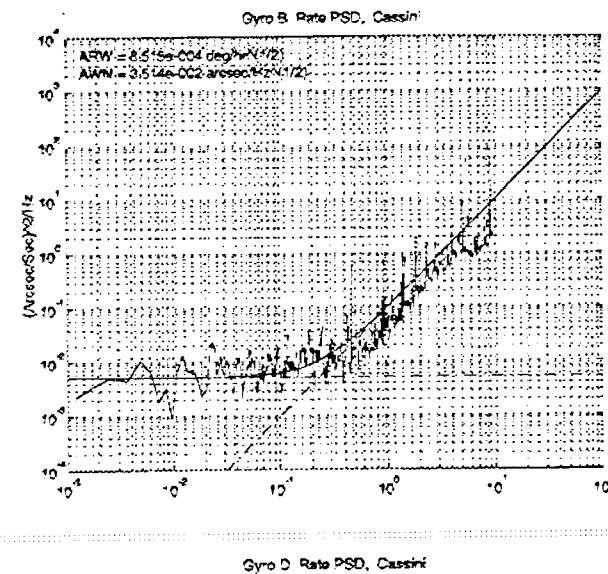
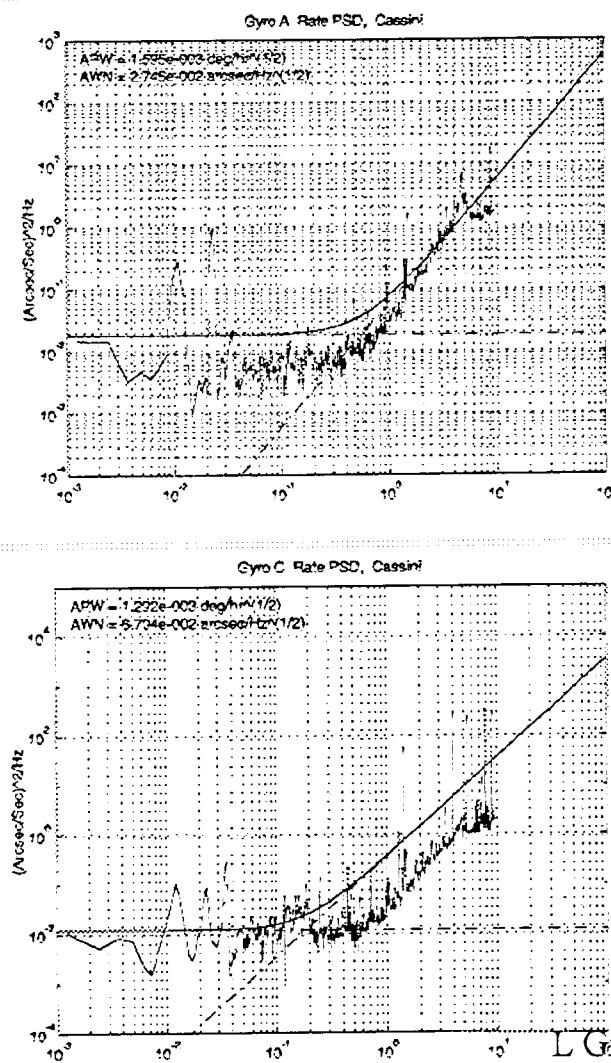




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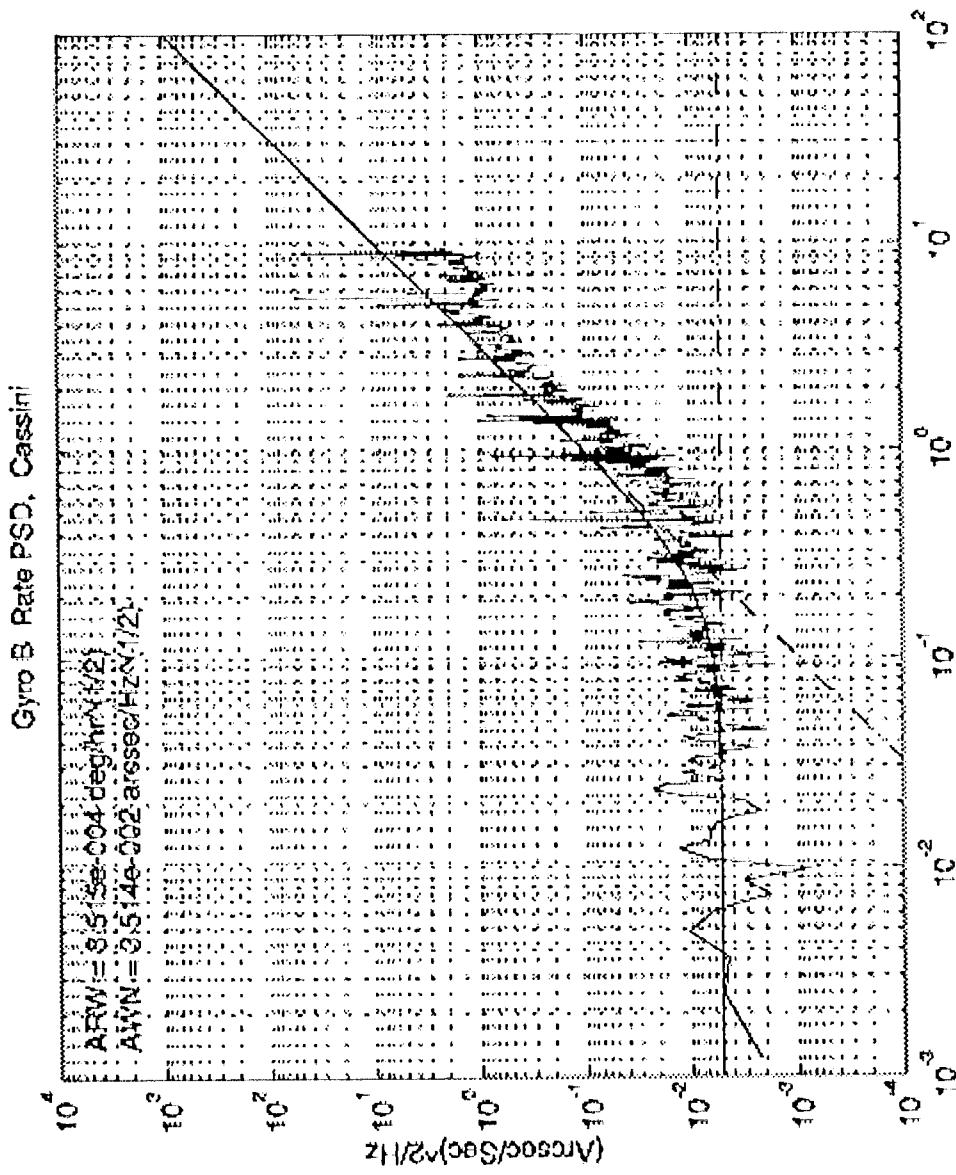
Typical Power Spectral Density for the Cassini IRU



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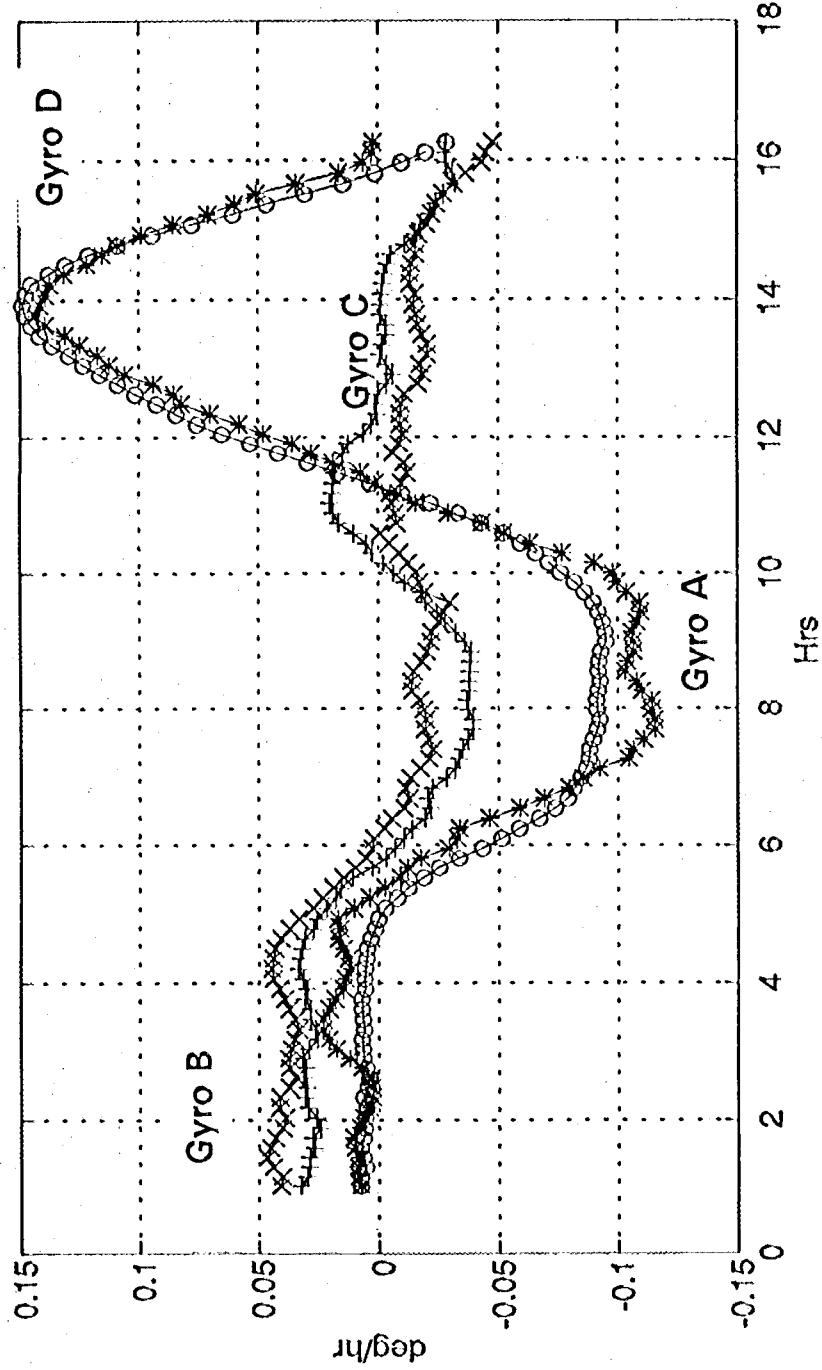
Typical Power Spectral Density for the Cassini IRU, Gyro B





Cassini IRU Bias Stability

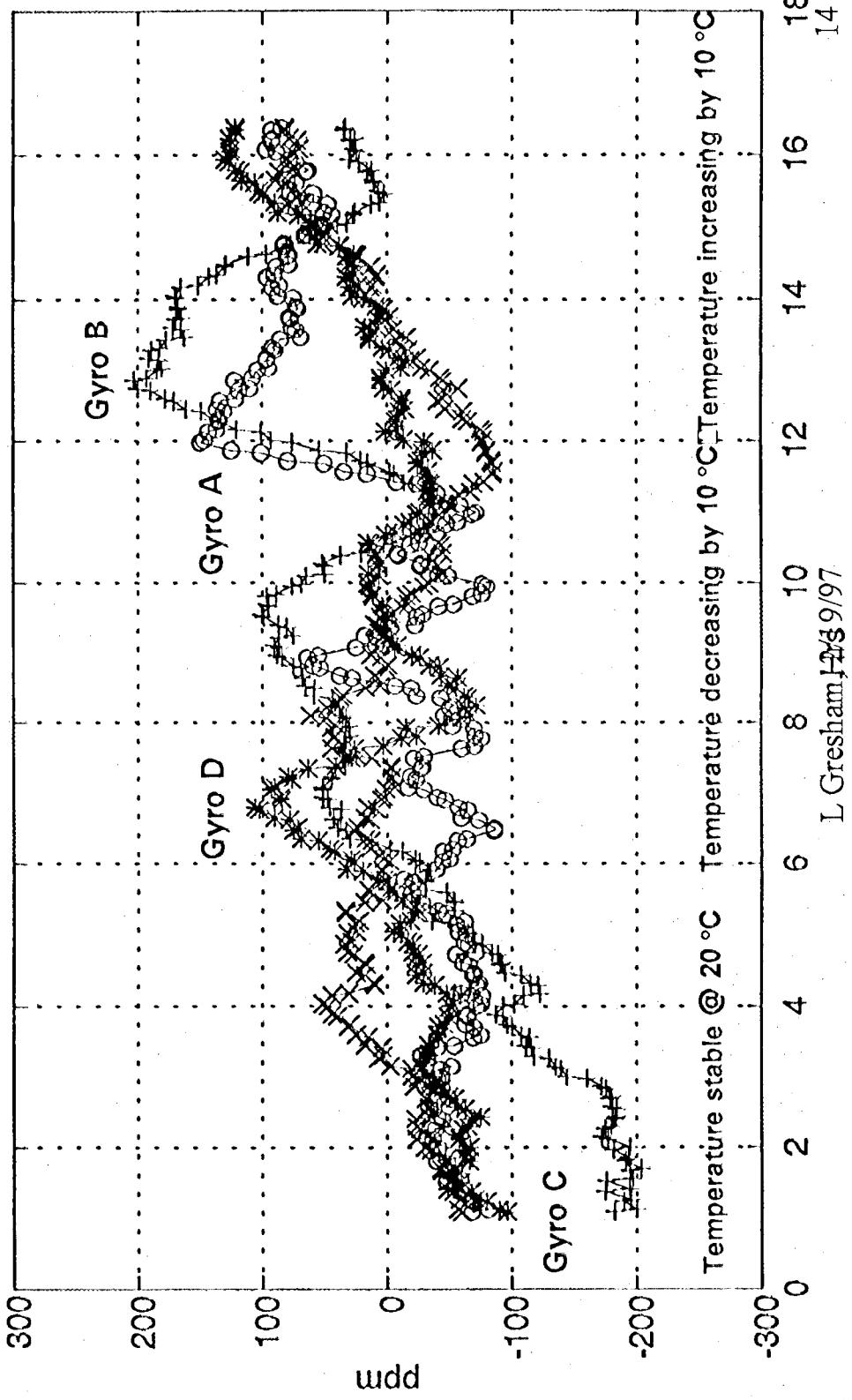
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